CALIBRATION OF AN ENERGYPLUS BUILDING ENERGY MODEL TO ASSESS THE IMPACT OF DEMAND RESPONSE MEASURES

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Hydro Québec

Contextualization

> **Hydro-Québec**
- Principal utility in Québec, Canada
- Total installed capacity of 35,829 MW in 2012
- HQ is interested in additional power sources for the network's future requirements

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Demand Response in CI Buildings

> **Represents a potential**

> **Power peak demand in CI buildings attributed mostly to:**
- Ventilation
- Air conditioning and heating
- Plug loads and lighting
- Domestic hot water

> **Identify appropriate measures for different building categories and HVAC configurations:**
- Modeling several buildings (Pilot project)
- Applying measures on calibrated models
- Assessing the impact on real buildings

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This presentation…

> **Focuses on one case study**

> **Gives an overview of:**
- The modeling methodology and the tools used
- The analysis of the measured and simulated data
- The calibration/parameterization process and the tools used to calibrate the model

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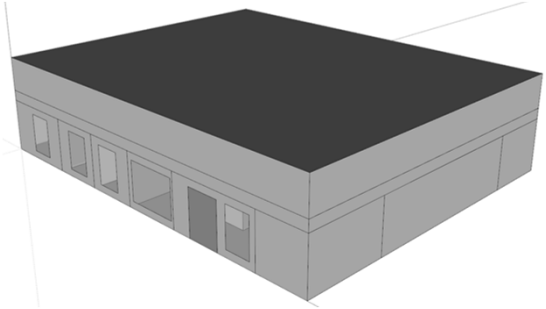
Case study

- > Commercial building located in Quebec
- > Built in 2009
- > ~25 kWh/pi²
- > 3 rooftop units
- > Heating source: electricity



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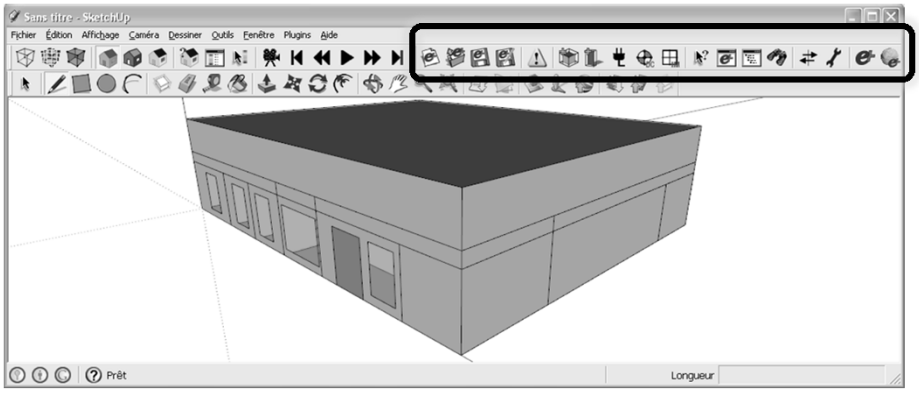
Creating the geometry

- > Geometry created with Google SketchUp
- > IDF (thermal zone definition) with OpenStudio Plugin



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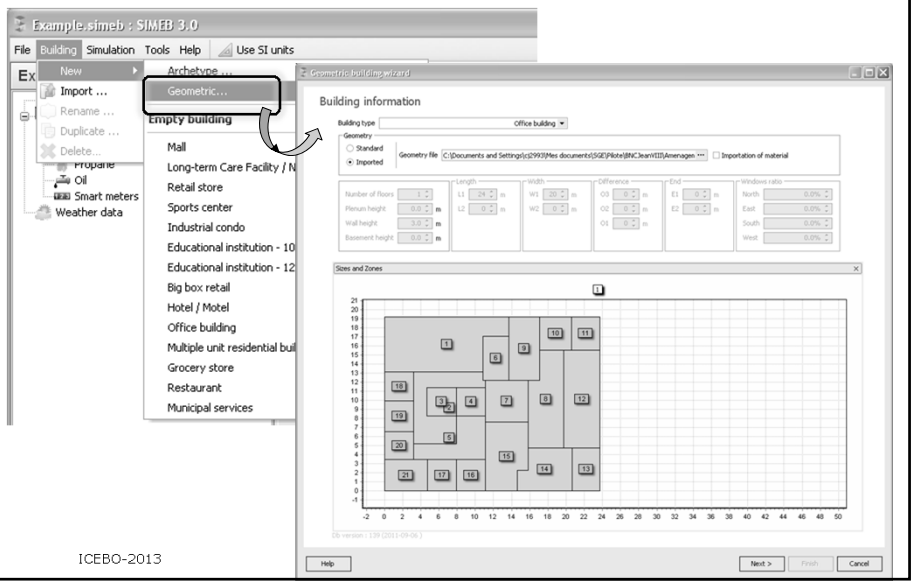
Importing geometry in SIMEB software



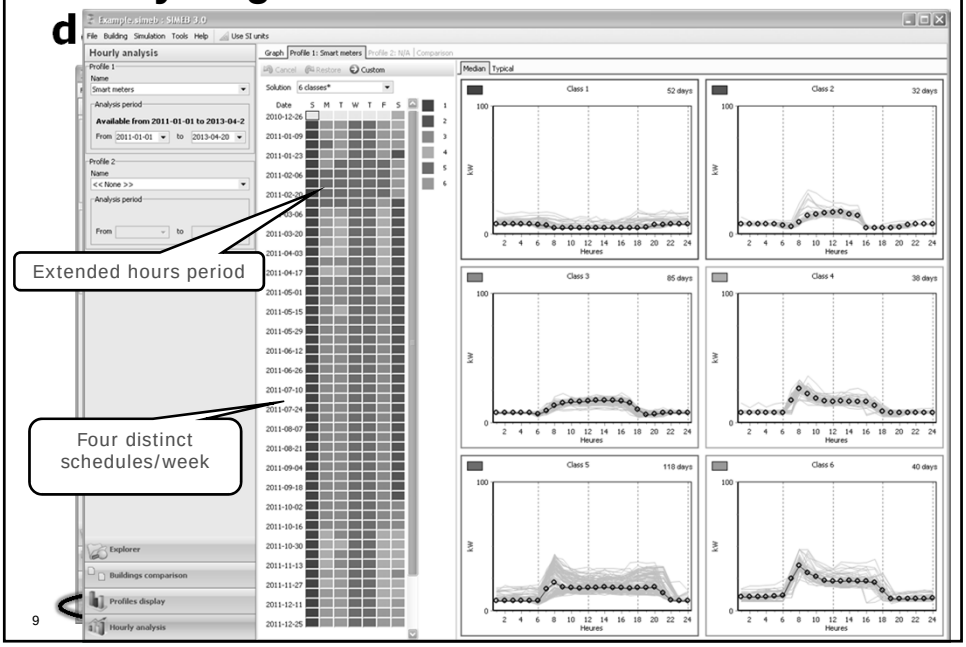
Creating a full building model in SIMEB

> **Define general parameters:**
  - Building envelope, window glazing
  - External lights
  - DHW…

> **Thermal zones specifications:**
  - Lighting, plug loads,…
  - Zone heating (baseboard, terminal reheat,….)
  - Occupancy and fresh air requirements
  - Schedules

> **HVAC Systems and Plants:**
  - Ventilation, heating/cooling capacities
  - Loops setpoints, etc.

Analysing measured and simulated d



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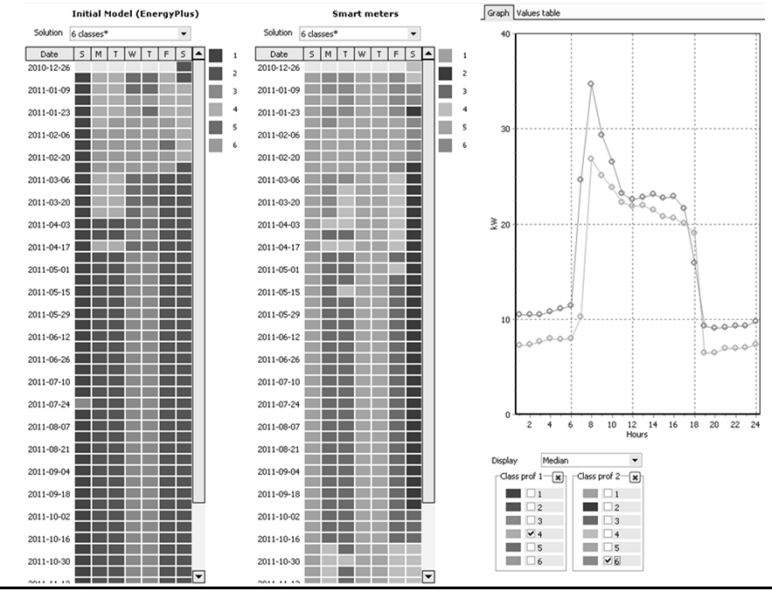
Analysing measured and simulated data



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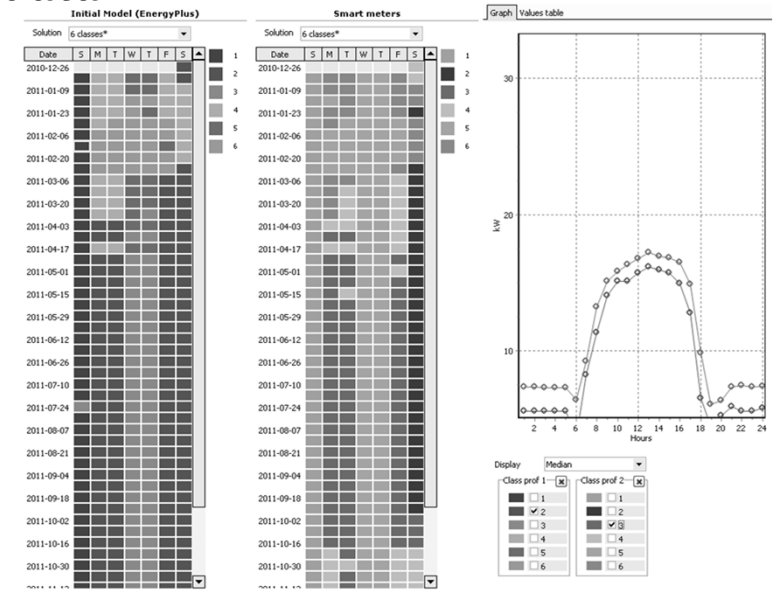
Analysing measured and simulated data



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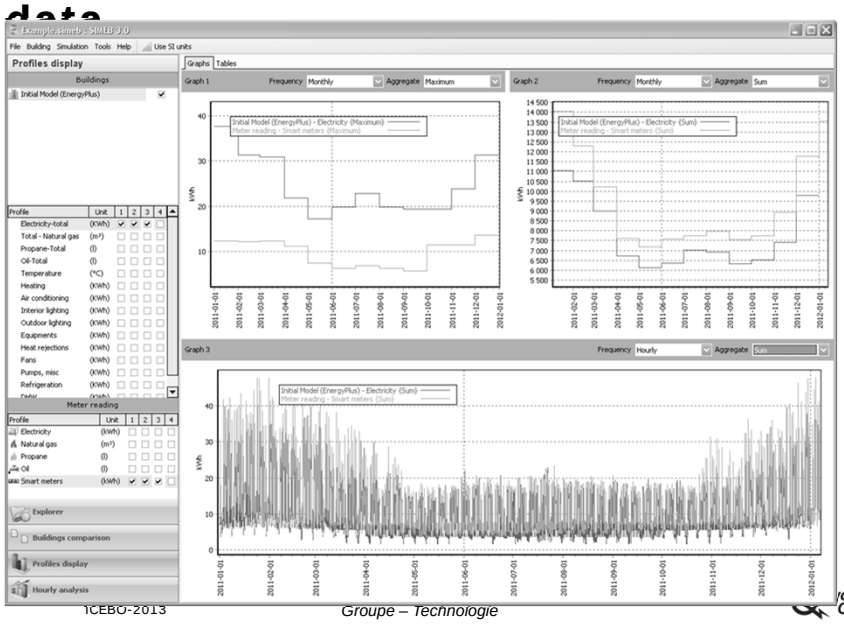
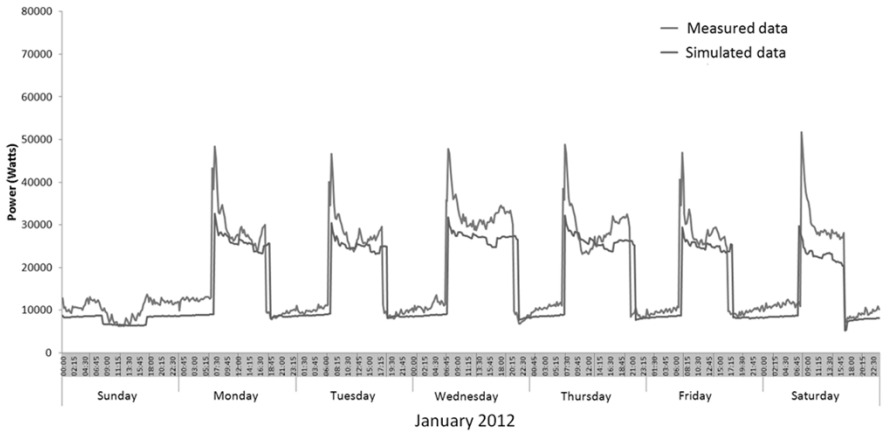
Analysing measured and simulated data



Analysing measured and simulated data



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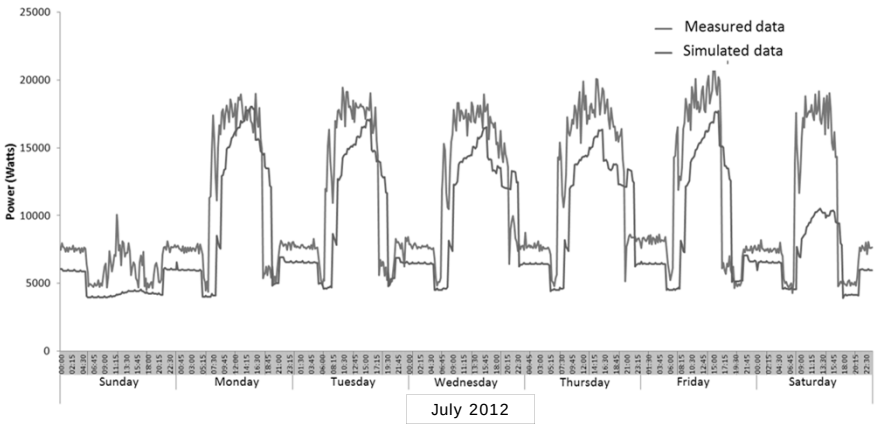
Analysing measured and simulated data



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Sensitivity analysis and calibration

> **Identify influent parameters by launching simulations with different values (extreme)**
  - Hints from SIMEB Pre-Calibration Module
  - Window types, Envelope R-Value, Minimum OA, Static fan pressure, Plug load intensity, etc.

> **Establish an optimization plan (↓ Δ simulated and measured profiles)**
  - Parameter selection and their limits
  - Calibration period (annual or specific period)
  - Objective function and type of algorithm (PSO, GPS,...)

> **Launch and manage optimization runs**

Sensitivity analysis and calibration

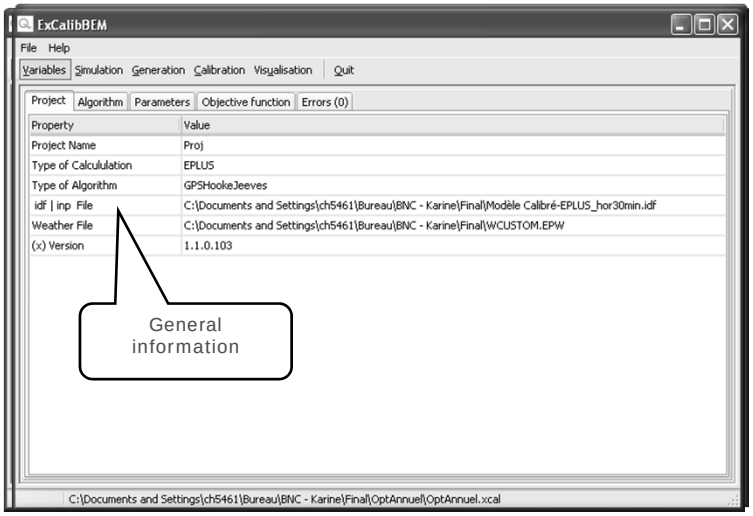
> **ExCalibBEM Software (in development) has been used to perform these previous tasks**

  > **Interface to GenOpt, developed by LBNL DOE Lab**

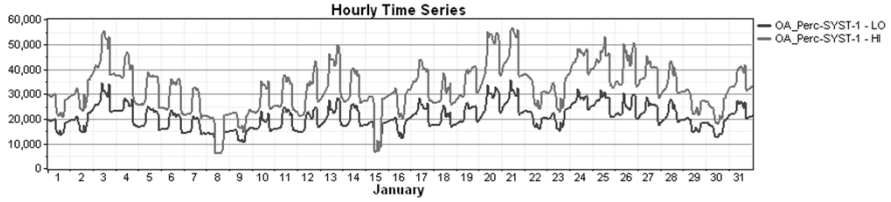
Optimization program integrating multiple algorithms for the minimization of a cost function that is evaluated by an external simulation program, such as EnergyPlus.

  > **Easy creation of IDF templates and Objective functions coupled with external log data**
  > **Easy retrieving and plotting of results (DVIEW format)**

Quick look at ExCalibBEM interface



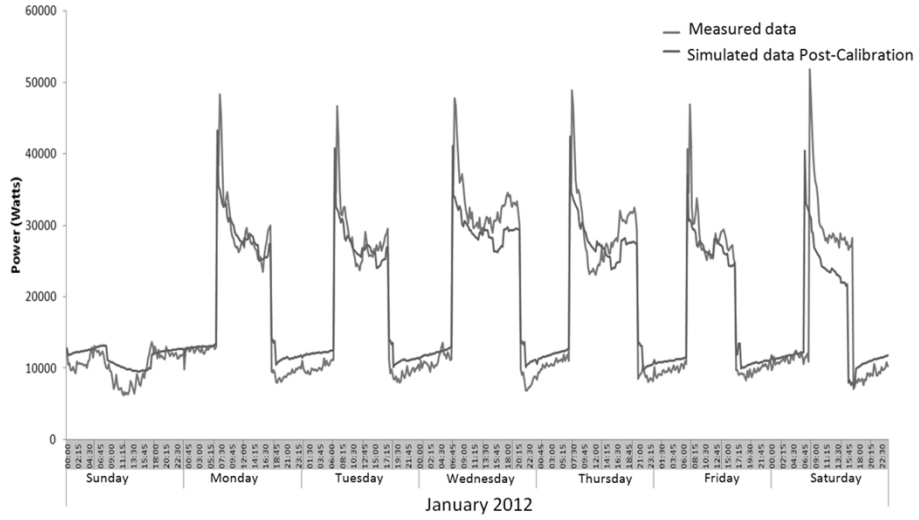
Sensivity analysis



Parameter	Winter	Summer
OA SYST-1 to SYST-3	VHI (Offset)	LI
Envelope R value	HI (Peak demand)	LI
Fan Static Pressure SYST-1 to 3	VLI	HI (Peak demand)
Clear glass instead of tint glass	LI (Peak demand)	LI (Peak demand)
Plug loads for 3 majors zones	LI	HI (Offset)

V : Very, L : Low, H : High, I : Impact

Calibration Results



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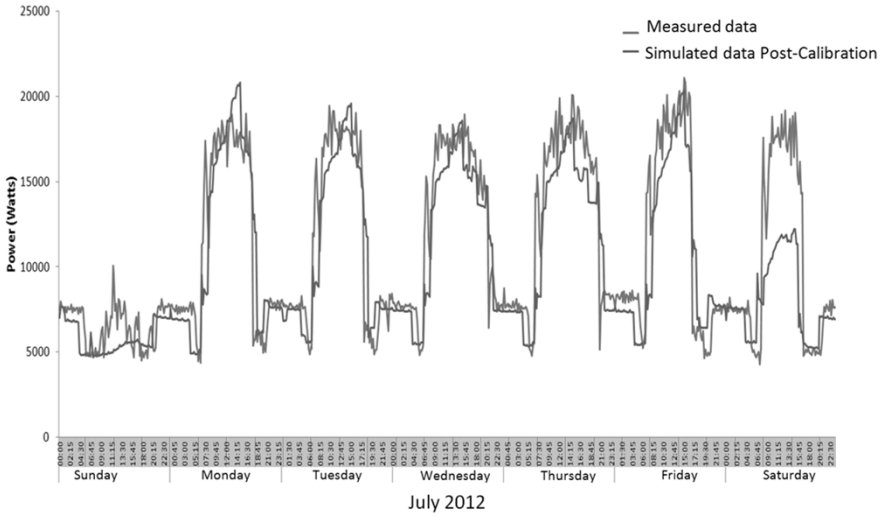
Calibrated Results



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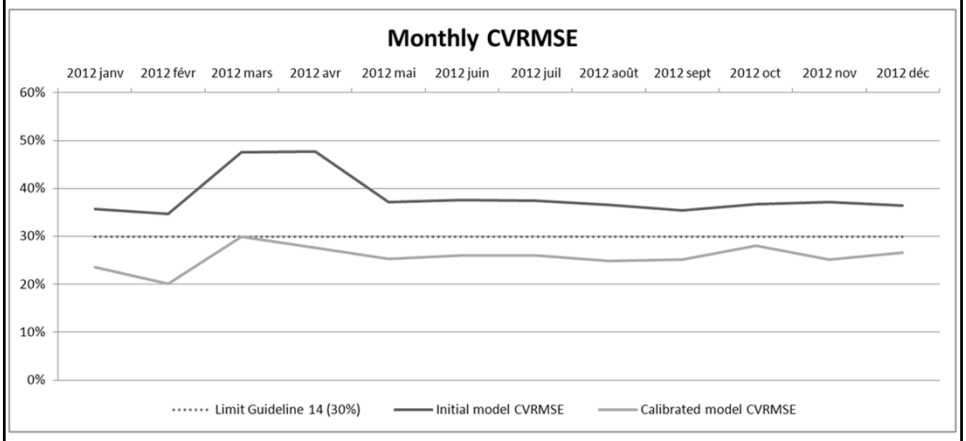
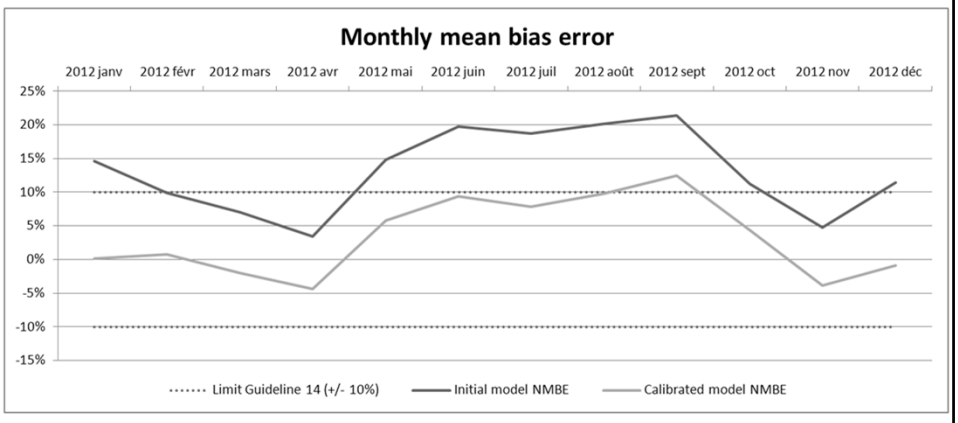
Calibrated Results



Calibrated Results



Conclusion

- **Calibrating model for a demand response objective : Challenging and High Effort**
  - **Capturing building and human erratic behaviour**
  - **HVAC control prediction**
- **Tools must be developed to facilitate:**
  - **Model creation**
  - **Analysis between simulated and measured profiles**
  - **Parameter identification for calibration**
  - **Parametric and optimization runs**
- **The model will be refined and used to assess the impact of demand response measures**

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